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This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
DARRELL GRAYSON	HIGGINS	TRINITY, NC

Additional inventors are being named on the ____________ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

SLIDE BODY INTERNAL COMBUSTION ENGINE

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☑ Customer Number: 24386

OR

☑ Firm or Individual Name	ROBERT W. PITTS				
Address	PO BOX 11483				
Address					
City	WINSTON-SALEM	State	NC	Zip	27116-1483
Country	US	Telephone	336-760-9565	Fax	

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Respectfully submitted,

SIGNATURE Robert W. Pitts

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TYPED or PRINTED NAME ROBERT W. PITTS

REGISTRATION NO. 27372
(if appropriate)
Docket Number: 03040

TELEPHONE 336-760-9565

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SLIDE BODY INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to internal combustion engines, especially to internal combustion engines that can be used in mobile vehicles. This invention also relates to internal combustion engines in which multiple pistons are joined as part of a rigid subassembly.

Description of the Prior Art

A four cylinder horizontally opposed "Flat Four" or "Boxer" engine includes four cylinders, which are mounted horizontally in opposed pairs. The term "Boxer Engine" describes the motion of the four pistons as they move back and forth in opposing pairs, much like a boxer's arms. This engine was first introduced in the late 1930's. The horizontally opposed layout of the cylinders helped to balance out the forces exerted on the crankshaft by the moving pistons and the connecting rods, which connected each individual piston to a centrally mounted crankshaft. Although pistons were located on opposite sides of a central crankshaft, opposed pistons did not move along the same axis, and the four pistons moved along four parallel axes, which intersect the crankshaft at different lateral positions. Unlike the present invention, each of the pistons comprised a separate member with its own connecting rod, which moves angularly relative to both the crankshaft and the piston.

US Patent 6,082,314 discloses another type of opposed cylinder internal combustion engine. In this patent four cylinders are arranged in an H-shaped configuration. Two double acting or double-ended pistons, each with generally cylindrically shaped crows on opposite sides of flat rectangular parallelepiped middle sections, are mounted on a crank shaft so that each double acting piston reciprocates in opposed cylinders. The two double acting pistons, each of which is part of a one-piece member with piston crowns at either end, move in the same direction during each stroke, and circular slide blocks, eccentrically mounted on the crank shaft, are received in

openings between the piston crowns to replace connecting rods. A dynamic balance slide piece reciprocates along and axis perpendicular to the piston reciprocation. The SYTEC engine proposed by CMC Research House at the Department of Mechanical & manufacturing Engineering of the University of Melbourne also includes a bearing block that moves perpendicular to the motion of two double-ended, single piece pistons connected to a central crankshaft.

US Patent 2,370,902 also discloses multiple sets of double-ended pistons that move in the same direction during each stroke. In this case, connecting rods rigidly connected to pistons at opposite ends are themselves interconnected by a cross bar. Anti-friction rollers mounted on a slide bar secured to the cross bar move with the double ended pistons and engage cams in the form of star shaped plates to impart rotation to a drive shaft.

In US Patent 4,011,842, a pair of spaced parallel, double-ended cylinders straddle a crankshaft and two double-ended pistons are connected to the crankshaft by a T-shaped connecting member so that linear motion of the double-ended pistons causes rotation of the crankshaft. The two doubled-ended pistons move in opposite directions. US Patent 6,446,587 and US Patent 6,073,595 are other examples of internal combustion engines with double-ended pistons moving in opposite directions.

It has been suggested that internal combustion engines with double-ended pistons can also be used to produce an electrical current. In US Patent 6,532,916 an oscillating alternator coil attached to a moving double-ended piston in an internal combustion engine moves through a magnetic field imparted by a stationary magnet. In some small internal combustion engines and alternator often comprises a ring of magnets mounted on a rotating flywheel, which act in conjunction with stationary core and windings on the engine body. Two examples of such devices are shown in US Patent 3,828,212 and US Patent 4,101,371.

The instant invention is believed to include many of the advantageous features represented by these examples of the prior are, but achieves these improvements by employing a configuration in which the components are easier to fabricate and in which assembly is simpler. The instant invention should therefore be easier to service since assembly and disassembly is more straightforward. The anticipated life and reliability of

the engine constructed according to this invention should also be significantly greater than has heretofore been possible with more elaborate engine configurations. Relative movement of component parts of this engine is believed to place less stress on moving parts, and these moving parts can be lubricated more efficiently and more effectively. The efficiency that can be achieved with this invention configuration is also believed to be superior to that which can be achieved with conventional internal combustion engine configurations. In view of the simplicity of the basic operation of this engine excessive vibration should not be a problem. In spite of the effort that has been expended to improve the performance of conventional internal combustion engine configurations, the piston slide body configuration of the instant invention should offer these and other advantages over these and other prior art configurations.

SUMMARY OF THE INVENTION

According to one aspect of this invention, an internal combustion engine can include the following components. A housing encloses a compartment with opposed cylinders at opposite ends of the compartment for receiving pistons. The pistons are mounted on a slide body reciprocal in the housing compartment The slide body has pistons at opposite ends of the slide body. Individual pistons are received within individual cylinders. Cyclical combustion within the cylinders imparts linear reciprocal motion to the slide body. A rotating disk, which can be a flywheel, is positioned in the housing compartment. The rotating disk is located adjacent to the slide body and is rotatable about an axis generally perpendicular to linear reciprocal movement of the slide body. Interengaging members on the slide body and rotating disk sufficiently laterally offset from the axis of rotation of the rotating disk impart rotary motion to the rotating disk as the slide body linearly reciprocates within the housing compartment. The assembly also includes a drive shaft extending through the housing. Rotation of the rotating disk is transmitted to the drive shaft so that linear motion of the slide piston is transmitted through the rotating disk to the drive shaft for delivering external power.

According to another aspect of this invention an internal combustion engine includes the following. Reciprocal pistons engage a rotary member to transfer linear

motion of the pistons to rotary motion, the pistons being mounted in a housing including the flowing housing components. The engine includes an upper cover and a separate lower cover. Side plates are attachable to and detachable from the upper cover and the lower cover adjacent opposite edges thereof to form a central housing subassembly having a generally rectangular cross section. A cylinder body can be attached to and detachable from one end of the central housing subassembly, the cylinder body including cylinders receiving the reciprocal pistons. A valve subassembly is attachable to and detachable from the cylinder body and encloses one end of the cylinders. This internal combustion engine can be assembled and disassembled by respectively attaching and detaching the housing components in surrounding relationship to the reciprocal pistons and the rotary member.

According to still another aspect of this invention, a piston subassembly for use in an internal combustion engine includes a central body including at least one arm extending from each end of the central body. The piston subassembly also includes cylindrical pistons on the distal ends of each arm, the central body, the arms and the cylindrical pistons comprising a rigid body such that as the piston subassembly moves through a complete cycle, and no relative angular movement of the cylindrical pistons, the arms and the central body occurs. The piston subassembly also includes an engagement surface on the central body, which engages a separate member during linear movement of the piston subassembly to impart rotary movement to the separate member to output energy due to combustion in the internal combustion engine.

According to a fourth aspect of this invention, an internal combustion engine includes an electrical generator, which comprises a flywheel located within a nonferromagnetic engine housing. The flywheel has a number of magnets attached thereto to increase the inertia of the flywheel and a plurality of electrical conductors located on the exterior of the nonferromagnetic engine housing. Rotation of the flywheel relative to the electrical conductors generates an electrical current in the electrical conductors.

A four stroke internal combustion engine, according to a fifth aspect of this invention includes a piston subassembly movable in opposite directions on each successive stroke. The piston subassembly includes a slide body with an even number of

at least six pistons. An equal number of pistons are located on opposite ends of the slide body, and pistons on opposite ends of the slide body face in opposite directions. Combustion occurs in a sequence such that the resultant force acting on pistons during each stroke is parallel to the direction of movement of the piston subassembly, and the piston subassembly does not bind during any stroke due to the absence of any resultant rotary movement of the piston subassembly.

According to a sixth aspect of this invention, an internal combustion engine includes a plurality of linearly reciprocal pistons, all of the pistons moving in the same direction during each stroke. The internal combustion engine also includes a flywheel having an axis of rotation substantially perpendicular to the direction in which the pistons move. The flywheel has sufficient angular momentum to dampen reaction forces acting in a direction opposite from the direction of movement of the pistons during sequential strokes due to the expansion of a combustible fuel-air mixture sequentially acting on individual pistons so that the internal combustion engine can be employed in a mobile vehicle, such as an automobile or other motor vehicle, and airplane, a lawnmower, off the road vehicles, and in many other applications.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a view showing one side and the top of an assembled internal combustion engine according to this invention.

Figure 2 is a view, taken from one end, showing the assembled internal combustion engine of Figure 1.

Figure 3 is a view of one end of the internal combustion engine of Figures 1 and 2, after removal of one of the cylinder head covers, showing the gears which actuate the valves.

Figure 4 is a view of a top plate subassembly, after removal from the internal combustion engine, showing the valve actuating shaft.

Figure 5 is a view showing removal of the valve subassembly showing the one cylinder body, with the ends of two pistons in two side by side cylinders.

Figure 6 is a view of the main housing, including the cylinder housing bodies, after removal of the top plate subassembly to reveal the slide body and the flywheel.

Figure 7 is a view of the flywheel and the bottom plate disassembled from the main body housing and the slide body.

Figure 8 is a side view showing a portion of one side panel removed from engagement with a one of the cylinder bodies to reveal the slide body.

Figure 9 is a top view of a slide body with four pistons.

Figure 10 is a view of a portion of the internal surface of one of the side plates, showing the lubrication jets adjacent a recessed portion that provides clearance for the flywheel.

Figure 11 is a view similar to that of Figure 10 showing the internal surface of the entire side plate.

Figure 12 is a view showing the linear bearing that would be mounted on a surface of the side plate shown in Figures 10 and 11. The linear bearing has been rotated from its operational position for a better view.

Figure 13 is a view of the inwardly facing surface of one of the cylinder bodies, showing two cylinders, which receive side-by- side pistons.

Figure 14 is a view of the outwardly facing surface of one of the cylinder bodies, showing the void areas through which coolant is circulated.

Figure 15 is a view of a portion of the main housing after the slide body and the flywheel have been removed.

Figure 16 is a view of one of the side edges on the central portion of the piston slide body. This edge engages the linear bearing shown in Figure 12.

Figure 17 is a view of the inner surface of the lower plate or cover, showing the grooves in which upper housing plates fit.

Figure 18 is a view of the exterior surface of the lower plate or cover, showing cavities in which coils mounted on a coil plate will fit when the coil plate is assembled on the exterior of the lower cover plate.

Figure 19 is a view of the flywheel showing the magnets mounted on the side of the flywheel from which the drive shaft extends.

Figure 20 is a top view of a slide body cast as a single unit, with the track mounted on one surface of the central portion and in which each piston is cast as a member having parallel faces.

Figure 21 is an end view of the slide body shown in Figure 20.

Figure 22 is a view of a spline shaft and linearly reciprocal cylinder, which can be used as an alternate configuration for mounting the piston slide body in the housing.

Figure 23 is a plan view of an alternate version of the piston slide body in which six pistons extend from the central body portion, and in which the central piston on each side is larger than the flanking pistons so that the forces exerted when the engine is fired can be more readily balanced.

Figure 24 is another view of the head.

Figure 25 is a side view of the head shown in Figure 24.

Figure 26 is an end view of the head also shown in Figures 24 and 25.

Figure 27 is a view of the shroud that is mounted on the top cover plate and encloses the valve shaft.

Figure 28 is a view of a coil pack mounted on the shroud shown in Figure 27.

Figure 29 is a schematic of a top view of an alternate embodiment of a piston slide body with sixteen pistons with pistons located above and below the elevation of the central body.

Figure 30 is a side view of the alternate embodiment of Fig 29.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although not limited to a four stroke, two cycle internal combustion cycle, this invention will be described in terms of this representative configuration. It should be understood that the basic invention can be adapted to other internal combustion cycles by one of ordinary skill in the art and that this invention can be implemented as different configurations, which would be apparent to one of ordinary skill in the art. Some aspects

of this invention are also suitable for use with apparatus other than an internal combustion engine.

The preferred embodiment of the internal combustion engine 1 according to this invention has two internal moving parts locating with a housing to deliver the power generated by the combustion of an air fuel mixture. These internal moving parts are a slide body 50, which reciprocates in a straight line, and a rotating disk, which preferably is in the form of a flywheel 70. Both the slide body 50 and the rotating disk or flywheel 70, are located within the same compartment 36 formed by a main housing 10. The slide body 50 includes a plurality of pistons 56A-D and the rotating disk or flywheel 70 is connected to an external drive shaft 74. In the preferred embodiment, linear movement of the slide body 50 is transmitted to the flywheel 70 by engagement of a pin 72 located on the flywheel 70 with a track 62 located on the slide body 50.

Valves 92 and means for operating the valves are located in a valve-cam subassembly 90 located at the ends of the main housing 10. In the preferred embodiment an external valve shaft 100 is rotated in response to linear movement of the slide body 50. The engine 1 can be carbureted or fuel injected. A conventional external electric oil pump (not shown) with sufficient oil pressure to spray lubricant to moving parts is used for engine lubrication in this embodiment. An alternative mechanical oil pump that can be consolidated as part of the internal combustion engine 1 will be subsequently discussed. The engine 1 is cooled by an external electric water pump, which moves coolants throughout the engine 1. External mechanical oil and water pumps can also be used.

The main housing 10 includes four main interlocked parts 16, 20, 24, 26 that can be fitted together with a minimum number of fasteners to simplify assembly and disassembly of the engine 1. These four interlocked parts 16, 20, 24, 26 surround the main housing compartment 36 in which the slide body 50 and the flywheel 70 are located. Two cylinder bodies 40A and 40B are located at opposite ends of the main compartment 36. A plurality of side by side cylinders 42A-D communicate with the main housing compartment 36. These cylinders 42A-D extend through the cylinder bodies 40A and 40B, and valve-cam-head subassemblies 90, including a head 96 on which intake and outlet ports 106, 108 for each cylinder are located, close the ends of the

cylinders 42A-D. The mechanism for opening and closing the valves are also located on these valve-cam plates 98. In the preferred embodiment, valve-cam gears 94 driven by the external valve shaft 100 are located on the valve plates 98.

In the preferred embodiment, multiple pistons are located on each end of the slide body. These pistons are rigidly connected as part of the slide body, and the pistons reciprocate within the cylinders without side forces between the pistons and the cylinders, thus causing only even, circular wear on the cylinders. The slide body includes a central body, which reciprocates along a tongue and grooved or bearing tract relative to the housing side plates to insure that the slide body moves linearly without any significant angular movement. The housing 10 and other components will be discussed in greater detail after a more thorough description of the primary moving parts that translate the combustion of a fuel air mixture into usable external power.

Combustion of fuel-air mixture in the cylinders 42A-D causes expansion of the gas and forces the pistons 56A-D outward during this expansion stroke. The preferred embodiment is intended for use in a standard four cycle, two stroke engine, although the basic invention can be employed for two stroke engines, for Diesel engines or for other conventional internal combustion engine cycles.

The first embodiment of this invention includes four cylindrical, reciprocal pistons 56A-D, two of which are located on each end of the slide body or slide body piston subassembly 50. This invention is not limited to a four cylinder configuration and other configurations, and their characteristics, will be discussed in more detail after describing the representative embodiment of Figs 1-19. The pistons 56A-D are joined to the slide central body 60 by piston arms 54. Piston arms 54 do not comprise a linkage permitting relative movement between the pistons 56A-D and the central body 60 in the sense in which connecting rods form a movable linkage between pistons and the crankshaft of a conventional internal combustion engine. The central body 60, the pistons 56A-D, and the arms 54 form the rigid slide body 50, whose motion, in the housing compartment 36, is essentially confined to linear movement parallel the mutually parallel axes of rotation of the four cylindrical pistons 56A-D. Substantially no angular movement of the rigid slide body 50 relative to any of three orthogonal axes and especially with respect to the cylinders 42 will occur. Since the pistons 56A-D move

along coextensive axes of the pistons 56A-D and the cylinders 42A-D, with no side force exerted by rocking piston rods as in a conventional internal combustion engine, there will be relatively little wear on the cylinder walls 44. Although the pistons 56A-D and the arms 54 can be rigidly attached or fastened to each other and to the central body 60, this rigid configuration lends itself to fabricating the slide body 50 as a one-piece member. In the preferred embodiments, the slide body 50 will be die cast as a one-piece member. The one configuration of the slide body 50 lends itself to being cast from a light weight material, such as aluminum or from brass or zinc or other materials so long as the material has sufficient structural strength and integrity to withstand the forces exerted upon the slide body 50 and its constituent elements. The integral slide piston subassembly 50 can also be machined. In the embodiment of Figure 9, the central body 60 and the arms 54 have substantially the same thickness. It should be understood, however, that the central body 60 would normally not be cast as a member having constant thickness, but instead would have strengthening ribs surrounding sections have less thickness. This common technique results in the removal of material that is not necessary to bear the loads encountered by the slide body piston subassembly 50 and results in a lighter weight structure. In addition to the economies realized by saving material, such a cast web configuration can also accelerate the cooling of the cast material resulting in a lower cycle time and more economic fabrication of the slide body subassembly 50. In some configurations it could be possible to also fabricate the piston arms 54 in a similar web configuration or in a hollow or partially hollow configuration, but the piston arms 54 must have sufficient strength to carry the compressive loads imparted to the pistons 56A-D by combustion during typical internal combustion engine cycles.

The embodiment shown in Figure 9 shows pistons 56A-D rigidly attached to arms 54. However, pistons 56A-D would preferably be cast as a part of the one piece slide body 50. When pistons 56A-D are cast in this manner, the pistons 56A-D can be cast as shorter cylindrical members, such as that shown in Figs. 20-21. The opposite ends of these integrally cast pistons 56A-D can be substantially parallel, each extending substantially perpendicular to the piston arms 54 and to the central body 60. It will then not be necessary to include tapered skirt as shown on the pistons 56A-D as seen in Fig. 9.

Piston grooves 58 will be formed around the pistons 56A-D, and conventional piston rings 59 will be seated within those grooves 58. These piston grooves 58 can be fabricated as part of the die casting operation in which the integral slide body 50 is fabricated or the piston grooves 58 can be subsequently machined as part of a secondary operation. The linear movement of the rigid piston slide body subassembly 50, and especially of the pistons 56A-D will result in even wear between piston rings 59 and the internal cylinder walls 44. The heads 96 will close off the top of each cylinder 42A-D, and O-rings 110 captured in O-ring grooves 112 in the head 96 will seal each cylinder 42A-D.

The central body 60 is relatively flat and has a height that is less than the outside diameter of the pistons 56A-D. The central body 60 also has a width that is greater than that of the individual piston arms 54, because the piston arms 54 must provide clearance for the pistons 56-A-D to reach top dead center in the respective cylinders 42A-D. The central body 60 also guides the four piston slide body subassembly 50 so that only linear movement is permitted without significant angular displacement during the piston stroke. In the representative embodiment of Figs 1-19, side edges of the central body 60 engage internal walls of both housing side plates 24, 26 to keep the piston slide body subassembly 50 and the pistons 56A-D reciprocating on a straight linear path as the engine cycles. In this first embodiment, edges 63 or surfaces projecting from these edges slide within straight recesses extending along the internal walls of the side plates 24, 26. A linear bearing 64 fits between the side plates 24, 26 and the edges 63 or edge projections to limit frictional engagement. In a four piston, four stoke, two cycle version of this invention, the individual pistons 56A-D will fire at four different times. Since the axes of rotation of each piston is offset from the center of mass of the slide body 50, there will be a moment created, which would tend to cause the slide body to move angularly if not for the fact that the edges of the central body 60 are restrained in this manner. In other words the slide body 50 would tend to cock or a "bureau drawer" would be created if not for this lateral restraint. However, since the entire central body 60 is laterally restrained, the slide body 50 will move only along a linear path and will not tend to bind. Other configurations can also be employed to guide movement of slide body 50 and pistons 56A-D relative to the cylinders 42A-D. A relatively simple tongue and groove

configuration can function as a guide in a similar manner, especially since moving parts in the internal housing compartment 36 will be thoroughly lubricated in a manner that will be subsequently discussed in greater detail. An angular type linear ball spline, such as that shown in Fig. 22 can also be employed. Each edge of the central guide body 50 can be fastened to external linear bearing cylinder bodies 140 carried on spline shafts 142. This second alternative configuration can also serve as an alternative means for attaching the cylinder bodies 40A, 40B and the valve subassemblies 90 on opposite ends of the main housing 10. Although the representative embodiment of Figs. 1 to 19 can be readily assembled and disassembled in a manner that will be discussed in greater detail in a later section, use of the spline shafts 140 as fastening means will even further simplify construction and service of internal combustion engines embodying this invention.

The central body 60 also includes a push-pull track located on its lower face. This push-pull track extends at an acute angle relative to the axes of the pistons 56A-D as well as to the direction of travel of the piston slide body 50. The track 62 is a formed steel member, which is more resistant to wear than the cast piston-slide body 50. Track 62 has a width sufficient to receive a cam pin 72 and its surrounding ball bearing 76, which extend upward from one face of the flywheel 70 and are seated in the track 62. As the slide body piston 50 reciprocates, the linear movement of the piston slide body 50 is transmitted through the engagement of the projecting pin 72 with the track 62 to impart rotary motion to the flywheel 70.

The flywheel 70 is mounted below the piston slide body 50. Flywheel 70 is generally parallel to the piston slide body 50 so that the axis of rotation of the flywheel 70 extends perpendicular to the slide central body 50 and to the direction of linear reciprocation of the pistons 56 A-D during each stroke. A drive shaft 74 extends from the opposite face of the flywheel 70 from which the pin 72 projects. In this embodiment, the flywheel 70 is located in the same internal housing compartment 36 in which the pistons slide body subassembly 50 is located. The drive shaft 74 extends through an opening of the lower plate or cover 20 to provide a power takeoff on the exterior of the housing 10. The pin 72 and the pin bearing 76 are offset from the axis of rotation of the flywheel 70, which is also collinear with the axis of revolution of the drive shaft 74. The pin 72, which engages the piston slide body 50 in track 62, thus revolves around the

center of mass and the axis of rotation of the flywheel 70. To insure that the flywheel 70 is balanced around its axis of rotation and that the axis of rotation extends through the center of mass, openings 78 have been machined into the flywheel 70 adjacent the periphery of the flywheel radially beyond the pin 72 and bearing 76.

The flywheel 70 is cast from a material, such as aluminum, in the same manner as the piston slide body 50 and other components of this internal combustion engine 1. The mass of the flywheel 70 can, however, be increased by adding weight around the axis of revolution of the flywheel 70. In the preferred embodiment mass has been added to the flywheel by attaching magnets 80 to the flywheel 70 evenly around the drive shaft 74. The mass of the rotating flywheel 70, including magnets 80, is greater than the mass of the piston slide body subassembly 50 in the first embodiment of this invention. Typically mass is added to conventional flywheels by adding mass to the flywheel rim. In this embodiment, the magnets 80 are located closer to the center of the flywheel 70, and the mass of these magnets is greater than the mass of magnets, or other weights, that could be added adjacent to the flywheel rim and would result in the same moment of inertia. The magnets 80, are however to be used for the generation of electric current, in a manner which will be subsequently be described in more detail, and larger magnets 80 are suitable for that purpose. Therefore it was deemed appropriate to employ larger magnets 80 closer to the flywheel axis of revolution instead of smaller magnets adjacent the periphery of the flywheel 70.

In the main representative embodiment, the flywheel 70 is located within the housing compartment 36. It should be understood however that a separate rotating disk, including a drive pin, could be mounted on the interior of the housing, and the flywheel could be mounted outside the housing 10. An intermediate shaft would join the separate rotating disk and an external flywheel in this alternative configuration. The main representative embodiment would, however, accomplish the same result with fewer parts.

The flywheel 70 functions as an energy storage device to dampen or reduce the fluctuations or variations of the velocity of the piston subassembly 50 during each stroke. Obviously the force acting on the piston subassembly 50 during combustion and during the initial stages of the expansion stroke of any one piston 56A,B,C or D than during later stages of each stroke, especially as the fuel air mixture is compressed in another cylinder

42A,B,C or D. The energy stored by rotation of the flywheel 70 will tend to reduce these velocity variations and smoothen reciprocation of the piston slide body 50.

The energy storage function of flywheel 70 is similar to flywheel energy storage in other conventional internal combustion engines. It is currently believed, however, that the flywheel 70 serves an additional function in the present invention. In the absence of other forces acting on the flywheel 70, the angular momentum of the rotating flywheel 70 will tend to remain constant. The direction of the angular momentum vector would also remain unchanged. When other forces act on the flywheel 70 the inertia of this flywheel 70 will make it more difficult for these forces acting on the flywheel 70 to change the direction of the angular momentum vector. In other words the angular momentum of the flywheel 70 will tend to dampen or reduce movement or vibrations, which might arise from other forces. Since the piston subassembly 50 moves in only one instant at any one time, there will be no tendency of oppositely moving pistons to balance the reaction forces acting on the engine housing as would be the case for conventional engines. However, the flywheel 70, which is connected to the housing, will tend to dampen any reaction forces acting on the engine housing 10 as a result of movement of the piston slide 50 in the opposite direction. Flywheel 70 thus serves to dampen any adverse effects arising from the elimination of pistons moving in opposite directions. Stabilizing this internal combustion engine 1 in this manner will make it more suitable for use in mobile vehicles, such as motor vehicles, air planes, lawn, garden and agricultural vehicles as well as in other off road applications. This description of the function of the flywheel 70 is currently believed to be accurate, but it is added here in an attempt to more completely describe the function of this internal combustion engine and its various components. This description is not intended to be limiting however, and any inadequate current understanding of the physics of this manner this engine and its operation does not limit the device as otherwise disclosed herein.

The combustion chamber of this engine is bounded by the cylinders 42A-D, the respective pistons 56A-D, and the heads 66, which are part of the valve- cam-head subassemblies 90. The heads 96 close off head ends of the cylinders 42A-D. The cylinder bodies 40A and 40B, one of which is shown from opposite ends in Figs.13 and 14 are attached to the side plates 24 and 26. Each cylinder body 40 comprises a cast

member in which the internal cylinder walls 44 extend from a cylinder body inwardly facing face 46. The cylinder body is evacuated around the cylinder walls 44 as seen facing toward the center of the engine housing as shown in Fig. 14. This evacuated area serves as a conduit for coolant in a manner to be subsequently discussed in greater detail. Alignment and mounting pins 48 extend outwardly from a peripheral cylinder body outer flange 49. These alignment and mounting pins 48 are received in openings on the head 96 as shown in Fig. 5.

The valve-cam-gear mounting plates , are attachable to the heads 96 which serve to close off distal ends of the cylinders 42A-D, and plate 98 serves as the means to mount other components of the valve-cam-head subassemblies 90A and 90B. Intake valves 106 and outlet valve 108 are mounted within a concave recess in the heads 96 in alignment with each corresponding cylinder 42 on each side of the engine 1. O-rings 110 in O-ring grooves 112 recessed in the heads 96 surround each concave recess and the valves 106, 108 for each cylinder 42. These O-rings 110 eliminate the need for a gasket surrounding the head of each cylinder 42. These O-rings are positioned to engage the outer faces 45 of the internal cylinder walls 44. Of course, a gasket could be employed instead of or in addition to the O-rings if desired. As shown in Figures 24-26, the valves 92 and the sparkplug 132, as well as The O-rings 110 are mounted on the head assemblies 96. Coolant openings 134 are located on an exterior side of the head subassemblies 96 so that water or other coolant can be circulated through the heads 96.

Cam gears 94 are mounted on the opposite side of the mounting plate 98. Four cam gears 94 are located on each end of the engine so that one cam gear 94 will activate one of the four valves 106, 108. Two cam gears 94 are positioned in alignment with each cylinder 42, and the teeth mesh on cam gears 94 of each pair. Cams on the inside of each cam gear 94 will engage the corresponding valve 106, 108 as each cam gear rotates.

A cam drive gear 101 mounted on each end of a valve cam shaft 100 drives the cam gears 94 of each pair. Rotation of valve cam shaft 100 thus imparts rotation to the cam gears 94 and causes the valves 106, 108 to open in proper sequence in relation to the position of the corresponding pistons 56A-D. Valve cam shaft 100 extends between opposite ends of the engine 1 above the internal housing compartment 36 in which the slide body 50 is located. Valve cam shaft 100 includes a continuous shaft groove 102,

which extends continuously in a serpentine path around the shaft 100. A valve shaft drive pin 86 projects upwardly from a inverted U-shaped mounting bracket 88 mounted on the top surface of the piston slide central body 60, as shown in Fig. 6. Drive pin 86 moves linearly with the piston slide body 50. This drive pin 86 is positioned within the continuous serpentine shaft groove 102, and linear movement of drive pin 86 imparts rotation to the valve cam shaft 100. The shaft 100 continues to rotate in the same direction, even though the piston slide body 50 reciprocates in opposite directions so the valve cam gears 94 also continue to rotate in the same direction. Alternatively, the shape of the groove 102 could be such that the shaft rotated in opposite directions during each successive stroke of the piston slide body 50, and the cam gears 94 could be modified to insure proper sequencing of the valve in that alternate configuration. The valve cam shaft is also mounted on a yoke 114 forming part of a partially open interior upper cover plate 16, which is in turn mounted on the top of the main housing 10. A timing wheel 115, located on shaft 100 serves as a reference via which engine timing can be regulated by external means.

A shroud 12, which is mounted on the top cover plate 16, encloses the top of the housing compartment 36 as well as the valve cam shaft 100. Shroud 12 is shown in Figure 27. Openings 142 are located on opposite ends of the shroud 12 to provide clearance for the valve cam shaft 100. Oil is sprayed through openings (not shown) on the interior of the shroud 12 so that the valve cam shaft can be lubricated. A coil pack 144 can be mounted on the shroud 12 as shown in Figure 28.

Valve covers 104 are mounted on opposite ends of the housing 10, and each valve covers 104 surrounds the valve-cam subassembly 90. An interior ledge 105 forms a surface on which the periphery of valve cam mounting plate 98 is seated. Valve covers 104 also include fins to more efficiently radiate heat.

The basic internal components for imparting linear motion to the piston slide body 50 by the sequential combustion of a fuel-air mixture in the cylinders 42A-D, and for conversion of this linear motion to a rotary motion for output via a drive shaft 74 have now been discussed. However, one important feature of this mechanism is the ease with which it can be assembled, dissembled and serviced. The construction of the main housing 10 contributes largely to these advantages. The housing 10 includes an upper

plate or cover 16 partially surrounded by an upper shroud 12, a lower plate or cover 16, two side plates 24, 26 and the two cylinder bodies 40A and 40 B at either end of the main engine housing 10. The two side plates 24 and 26 are captured at their upper and lower edges by interfitting grooves 18 on the upper cover plate 16 and lower interfitting grooves 22 on the lower cover plate 20. Upper cover plate 16 and lower cover plate 20 thus serve to hold the side plates 24, 26 in proper lateral position to define the top and sides of an internal housing compartment 36 in which both the piston slide body central portion 60 and the flywheel 70 are confined. The upper cover plate 16 is externally clamped to the lower cover plate 20 around the exterior of the side plates 24, 26. The cylinder bodies 40A and 40 B are fitted between recessed side faces 25 at opposite ends of the internal compartment 36 between end sections of the side plates 24 and 26 as shown in Fig. 7. A protruding, generally rectangular protuberance 27 on each side plate 24 or 26 fits within a correspondingly shaped depression on the side of the cylinder bodies 40A and 40B. The relatively tight fit between the rectangular protuberance 27 and the depression 41 holds the cylinder bodies 40A, 40B and the side plates 24 and 26. A silicone sealant can be used to seal this joint as well as other joints of the interfitting housing components. An alignment pin, which aids in assembly, is shown in Fig. 7, but if the height of a tapered protuberance 27 and the depth of a tapered depression are sufficient, this alignment pin can be eliminated. As shown in Fig. 7, the pistons 56A-D are positioned within the cylinders 42A-D before the side plates 24 and 26 are attached to the cylinder bodies 40A and 40B.

The sequence of steps for disassembling the internal combustion engine 1 illustrate the simplicity of servicing this engine and conversely the simplicity of its construction. After the engine is removed from the frame in which it is mounted, the valve covers 104 are removed as the first stage of the engine disassembly. The valve subassemblies 90A and 90B can now be removed at either end of the assembly. The next step in breaking down the engine 1 is to remove the upper shroud 12. Next the external clamps securing the upper cover plate 16 to the lower cover plate 20 are removed. The upper cover plate 16 is now free and can be lifted off of the side plates 24 and 26, which are then held in place only by the lower interfitting grooves 22. Removal of the lower plate 20 will then free both the side plates 24 and 26 from the cylinder bodies 40A and

40B. Removal of the lower cover plate 20 also permits removal of the flywheel 70, which is typically removed with the lower cover plate 20. The flywheel 70 must be removed from the bottom because a tapered cavity 28 is formed on the interior of each side plate 40A and 40B, as shown in Fig 11 to provide sufficient clearance for a flywheel 70, whose outer diameter is larger than the width of the piston slide body central portion 60. After the side plates 24 and 26 have been removed, the only remaining components are the piston slide body 50 with the pistons 56A-D still positioned within the cylinders 42A-D. Each cylinder body 40A and 40B can be removed from the slide body 50 freeing the pistons 56A-B, and disassembly of the engine 1 is now complete.

Oil is distributed though a channel in the side plates 24, 26 to lubricate the slide body 50 and the flywheel 70 in the internal housing compartment 36. Oil is also distributed through the valve covers 104 to lubricate the valve-cam subassemblies 90A and 90B. These oil distribution channels are embedded in the housing components and are not shown; but these channel distribute oil to oil spray jets 124 located in the side plates 24 and 26 and oil spray jets 126 located in the valve covers 104. Tubing, not shown, connects oil couplings 120 so that oil may flow between the side plates 24 and 26 and into the interior of the valve covers 104. The oil in the internal housing compartment 36 covers moving parts, such as the slide body 50 and the flywheel 70. Oil drains through an opening 128 in the bottom plate or cover 20 so that the oil and be drained to a reservoir and then returned. The spray jets 124 and 126 can be angled toward areas in which they will properly lubricate moving parts. Jets located on the interior of the shroud 12 serve a similar purpose. In the embodiment depicted herein, an external electric oil pump, not shown, is employed. Since there is no need to pump oil through confined spaces, such as through crankshafts and connecting rods of conventional internal combustion engines, less oil pressure will be required. A mechanical oil pump can also be incorporated into this invention. A oil pump piston can be added on top of the slide body central portion 60. This oil pump piston will be received by a oil pump cylinder on the housing 10 and check valves can be employed in the intake and outlet. As the slide body moves in opposite directions the oil pump piston will also reciprocate pumping oil through essentially the same path as employed in the main representative embodiment.

Liquid coolant is also dispersed by an external electric water or fluid pump, which although not shown, can be connected to the coolant intake 116 and exhaust 118 located on the side plate 24. The liquid coolant or water is transported between opposite ends of the main housing 10 through conduits embedded in the side plates 24, 26. Coolant apertures 31, one of which is shown in Fig. 8, communicates with this internal conduit in each side plate. Mating apertures 43, located in the cylinder bodies 40A and 40B also communicates with the void space surrounding each of the cylinders 42A-D. This void space, which provides room for coolant to surrounding cylinders 42A-D is best seen in Fig. 14. Openings 134, shown in Figure 25 also permit coolant to be circulated through the heads 96. Using these internal conduits and void passages, which can be part of original castings or can formed by secondary machining operations, permits coolant to circulate within the engine components and recirculation by the external water pump.

Electricity can be generated by magnets 80 mounted on the flywheel 70, which will move past electrical conductors in the form of coils 84 mounted on a coil plate 82 secured to the exterior face of the bottom plate or lower housing cover 20. As discussed previously the magnets 80 also serve the purpose of adding weight and mass to the flywheel 70, since they are bonded to the exterior of the flywheel. The coils 84 are formed by winding a first wire around iron cores in a first direction and then by winding wire around the same iron cores in a second direction. These coils 84 are then mounted on a mounting plate 82, which is secured to the exterior face of the bottom plate 20. As shown in Fig. 18, cavities 130 extend partially into the external face of the bottom plate 20. These cavities receive the coils 84, which are separated from the magnets 80 by a thickness of nonferromagnetic aluminum. The magnets 80, mounted on the flywheel 70 rotate within the internal housing compartment 36, rotate relate to the stationary coils 84 on the coil plate 82 located on the exterior of the housing 10. An electric current is induced in the electric conductors forming the coils 84 by relative movement of the magnetic field of the magnets 80. The electricity produced in this manner can be used to power external devices, such as the oil pump and the water pump as well as to charge an external battery. This electricity can also be tapped for other uses, which are not directly related to the functioning of this internal combustion engine 1. Although they would not add as much mass to the flywheel, coils could also be mounted on the flywheel instead of

using magnets. These flywheel mounted coils, which would be energized by an external electrical supply, would induce a magnetic field, which as it moved relative to the stationary coils 84, thus converting the kinetic mechanical energy of the rotating flywheel to electrical energy. The combination of flywheel mounted magnets, or other means of generating a magnetic field, along with the coils mounted on the exterior of the housing body 10 can also be used as a motor, by generating a variable current in the coils, which will cause the magnets to move and the flywheel to rotate according to well understood physical principles. This arrangement can be used as a starter motor by causing the flywheel 70 to rotate and the piston slide body 50 to reciprocate in a cyclical manner. Alternatively an electric motor of this sort can be used to deliver mechanical power for other purposes by attaching the rotating drive shaft 74, attached to the rotating flywheel 70, to an external implement. The same results could also be achieved by employing an externally mounted flywheel.

The main embodiment of the internal combustion engine 1 includes a single slide body 50 having four pistons 56A-D, two side by side pistons being located on opposite ends of the piston slide body subassembly 50. Alternative configurations can be employed. For instance, multiple slide body pistons 50 can be stacked one on top of each other. So long as both slide body piston subassemblies 50 move in the same direction, only one flywheel need be employed. If two slide bodies move in opposite directions, two flywheels can be employed, one connected to each slide body. The force generated by each pair can be transferred to a single drive shaft by conventional means. Alternatively, the same slide body can employ additional pistons extending above or below primary pistons located in the same major plane as the central slide body portion. Alternatively layers of pistons can be mounted so that one layer is below the principal plane of the central slide body portion and the other located above that principal plane. Schematics of a sixteen piston slide body assembly with pistons located above and below the central plane of the central body is shown in Figures 29 and 30. The lateral position of pistons in two layers can also be staggered.

Another option is to employ more than four pistons in a single slide body assembly. If at least six pistons, three located side by side on each side, are employed, a further advantage can be achieved. If the two exterior pistons are fired simultaneously on

both ends of the piston subassembly, and if the middle pistons are fired at different times, then the resultant force can always act through the center of mass of the slide body. Thus there will be no tendency of the slide body to become cocked as it moves, and there will be no "bureau drawer" effect. For example, if at the start of the first stroke of a four stroke, two cycle engine in the configuration shown in Fig. 23, pistons A and C are fired simultaneously, the resultant force would be directed through the center of mass. At the start of the second, or return, stroke pistons D and F were to fire, followed by piston B firing at the start of the third stroke with piston E firing at the start of the fourth stroke, all forces would be centrally applied to the slide body. This approach is enhanced if the two centrally mounted pistons B and E have a larger outside diameter, i.e. larger cylinder bore, than the other pistons. The force exerted on larger pistons B and E would be larger than that exerted on individual smaller pistons A,C, D, F. Since two smaller pistons are fired simultaneously, the forces resulting from fuel air mixture combustion would tend to even out, thus further balancing the forces exerted in the engine. For a four stroke, two cycle internal combustion engine, and even number of pistons equal to six or greater, can result in alignment of the resultant force exerted on the piston during each stroke with the center of mass of the piston slide subassembly.

One of the advantages of this invention is that the major components can be cast or fabricated as integral or one-piece members. The piston subassembly 50 shown in Fig. 9 includes four pistons that have been rigidly mounted on a one-piece cast member including the central body 60 and four piston arms 54. The pistons themselves can be cast or fabricated as part of this one-piece member and need not be separately attached. By casting the pistons as part of the one-piece member, the configuration of the pistons can be simplified as shown in Fig. 23. In this configuration opposite faces of the integrally cast pistons can have parallel faces, and each face can extend generally perpendicular to the primary plane of the central body and the piston arms. Piston ring groove can be cast so that conventional piston rings can be mounted on the exterior of either style piston in a conventional fashion. An oil retaining ring can also be cast and an oil retaining ring of conventional construction can be positioned adjacent to and on the inside of the piston rings. Pistons cast and assembled in this manner will function at least as efficiently as conventional piston subassemblies.

I CLAIM:

1. An internal combustion engine comprising:

a housing forming a compartment with opposed cylinders at opposite ends of the compartment;

a slide body reciprocal in the housing compartment, the slide body having pistons at opposite ends of the slide body, individual pistons being received within individual cylinders, cyclical combustion within the cylinders imparting linear reciprocal motion to the slide body;

a rotating disk positioned in the housing compartment, the rotating disk being located adjacent to the slide body and being rotatable about an axis generally perpendicular to linear reciprocal movement of the slide body;

interengaging members on the slide body and rotating disk sufficiently laterally offset from the axis of rotation of the rotating disk to impart rotary motion to the rotating disk as the slide body linearly reciprocates within the housing compartment: and

a drive shaft extending through the housing, rotation of the rotating disk being transmitted to the drive shaft so that linear motion of the slide piston is transmitted through the rotating disk to the drive shaft for delivering external power.

2. The internal combustion engine of claim 1 wherein the slide body and the pistons comprise a rigid body.

3. The internal combustion engine of claim 2 wherein the slide body and the pistons comprise a one-piece body.

4. The internal combustion engine of claim 3 wherein piston rings extend around the pistons and engage internal cylinder walls.

5. The internal combustion engine of claim 3 wherein the slide body with the pistons comprises a one-piece cast member.

6. The internal combustion engine of claim 2 wherein multiple pistons are located on each end of the slide body, multiple pistons on each end of the slide body extending into side by side cylinders on each end of the housing.

7. The internal combustion engine of claim 2 wherein the pistons and the slide body move only linearly, relative to the cylinders, without angular motion relative to the cylinders.

8. The internal combustion engine of claim 1 wherein the rotating disk comprises a flywheel.

9. The internal combustion engine of claim 1 wherein the interengaging members comprise a pin received within a track.

10. The internal combustion engine of claim 9 wherein the pin extends from the rotation disk into the track located adjacent to the axis of rotation of the rotating disk.

11. The internal combustion engine of claim 9 wherein both the slide body and the rotating disk comprise cast members and the pin and track are formed of a material having greater wear resistance than the cast slide body and cast rotating disk.

12. The internal combustion engine of claim 1 wherein the slide body and the rotating disk are surrounded by a lubricating media in the enclosure.

13. The internal combustion engine of claim 1 including linear bearings between sidewalls of the housing compartment and side edges of the slide body.

14. The internal combustion engine of claim 1 wherein the housing comprises an upper plate, a separate lower plate, and two side plates engaging both the upper plate and the lower plate adjacent opposite edges thereof.

15. The internal combustion engine of claim 14 wherein the housing compartment has a substantially rectangular cross section.

16. The internal combustion engine of claim 14 wherein the upper and lower plates interfit with the side plates adjacent opposite edges thereof.

17. The internal combustion engine of claim 16 wherein opposite edges of the side plates fit within grooves in the upper and lower plates respectively.

18. The internal combustion engine of claim 14 wherein the cylinders extend into cylinder bodies fitting between side plates at opposite ends of the side plates.

19. The internal combustion engine of claim 18 wherein a valve subassembly is attached to heads mounted on the cylinder bodies on opposite ends of the housing.

20. The internal combustion engine of claim 14 wherein coolant lines and oil lines extend through one of the side plates.

21. The internal combustion engine of claim 1 wherein the rotating disk comprises a balanced disk rotatable about the rotating disk center of mass.

22. The internal combustion engine of claim 1 including the sidewalls of the housing compartment and side edges of the slide body are joined by a tongue and groove configuration with the slide body reciprocating with respect to the sidewalls.

23. An internal combustion engine comprising:

reciprocal pistons engaging a rotary member to transfer linear motion of the pistons to rotary motion, the pistons being mounted in a housing further comprising housing components including;

an upper cover and a separate lower cover;

side plates attachable to and detachable from the upper cover and the lower cover adjacent opposite edges thereof to form a central housing subassembly having a generally rectangular cross section;

a cylinder body attached to and detachable from one end of the central housing subassembly, the cylinder body including cylinders receiving the reciprocal pistons,

a head attachable to and detachable from the cylinder body and enclosing one end of the cylinders and including valves; and

valve actuation means mounted on the head;

whereby the internal combustion engine can be assembled and disassembled by respectively attaching and detaching the housing components in surrounding relationship to the reciprocal pistons and the rotary member.

24. The internal combustion engine of claim 23 wherein the reciprocal pistons are fixed to a slide body, the pistons and the slide body moving only linearly, without rotary motion relative to the cylinders.

25. The internal combustion engine of claim 24 wherein the pistons and the slide body comprise a one-piece member.

26. The internal combustion engine of claim 25 wherein the one piece member comprises a cast one-piece member.

27. The internal combustion engine of claim 24 wherein the rotary member is also located in the housing.

28. The internal combustion engine of claim 27 wherein the rotary member comprises a flywheel.

29. The internal combustion engine of claim 28 wherein the flywheel is parallel to the slide body.

30. The internal combustion engine of claim 29 wherein pin and groove means on the slide body and the flywheel engage to covert linear motion of the pistons to rotary movement of the flywheel.

31. The internal combustion engine of claim 24 wherein a projection on the slide body engages a rotating shaft, connected the valve subassembly so that valves in the valve subassembly open and close in conjunction with linear movement of the reciprocal pistons.

32. The internal combustion engine of claim 23 wherein the reciprocal pistons, the rotary member, the upper and lower covers, the side plates, the cylinder body, and the heads comprise cast aluminum components.

33. A piston subassembly for use in an internal combustion engine, the piston subassembly comprising:

a central body including at least one arm extending from each end of the central body;

cylindrical pistons on the distal ends of each arm, the central body, the arms and the cylindrical pistons comprising a rigid body such that as the piston subassembly moves through a complete cycle, no relative angular movement of the cylindrical pistons, the arms and the central body occurs; and

an engagement surface on the central body comprising means for engaging a separate member during linear movement of the piston subassembly to impart rotary movement to the separate member to output energy due to combustion in the internal combustion engine.

34. The piston subassembly of claim 33 wherein the central body, the arms and the cylindrical pistons comprise sections of a one-piece member.

35. The piston subassembly of claim 34 wherein the piston subassembly comprises a one-piece cast member.

36. The piston subassembly of claim 33 wherein the cylindrical pistons comprise right circular cylindrical members having opposed parallel end surfaces extending transversely relatively to the arms.

37. The piston subassembly of claim 33 wherein the central body comprises a generally flat member with opposed parallel faces.

38. The piston subassembly of claim 33 wherein a plurality of side by side cylindrical pistons are located on opposite ends of the central body.

39. The piston subassembly of claim 33 wherein the engagement surface comprises a track extending at an acute angle relative to the linear movement of the piston subassembly.

40. The piston subassembly of claim 39 wherein the track is positioned in a cavity in the central body, the track being forming of a material having a greater wear resistance than the material from which the central body is formed.

41. The piston subassembly of claim 39 wherein a projection extends from a face of the central body opposite from the face on which the track is located, the projection comprising means engagable with another component of the internal combustion engine to cause valves to open and close during the internal combustion engine cycle so that combustion of an air-fuel mixture imparts linear movement to the piston subassembly.

42. The piston subassembly of claim 33 wherein linear bearings are located on side edges of the central body, the linear bearings extending in the direction of movement of the piston subassembly.

43. The piston subassembly of claim 33 including tongue and groove means on edges of the central body and on the housing.

44. The piston subassembly of claim 33 wherein each piston includes means engagable with a cylinder in which the piston head moves.

45. The piston subassembly of claim 33 wherein piston rings are located in grooves formed on the exterior of the cylindrical pistons so that the piston rings engage the cylinder in which the piston moves.

46. An internal combustion engine including an electrical generator, the generator comprising a flywheel located within a nonferromagnetic engine housing, the flywheel having a number of magnets attached thereto to increase the inertia of the flywheel and a

plurality of electrical conductors located on the exterior of the nonferromagnetic engine housing, rotation of the flywheel relative to the electrical conductors generating an electrical current in the electrical conductors.

47. The internal combustion engine of claim 46 wherein the electrical conductors comprise coils mounted on an exterior surface of the nonferromagnetic engine housing.

48. The internal combustion engine of claim 47 wherein the flywheel and the coils are located adjacent opposite surfaces of an external plate forming a portion of the nonferromagnetic engine housing.

49. The internal combustion engine of claim 48 wherein the plate and the flywheel are each cast from aluminum.

50. The internal combustion engine of claim 46 wherein the generator functions as an electric engine by applying a time varying current to the electrical conductors to impart rotation to the flywheel.

51. A four stroke internal combustion engine including a piston subassembly movable in opposite directions on each successive stroke, the piston subassembly comprising a slide body with an even number of at least six pistons, with an equal number of pistons on opposite ends of the slide body and with pistons on opposite ends of the slide body facing in opposite directions, combustion occurring in a sequence such that the resultant force acting on pistons during each stroke is parallel to the direction of movement of the piston subassembly such that the piston subassembly does not bind during any stroke due to the absence of any resultant rotary movement of the piston subassembly.

52. The four stroke internal combustion engine of claim 51 in which combustion simultaneously energizes at least two pistons on the same end of the piston subassembly at the beginning of at least one stroke.

53. The four stroke internal combustion engine of claim 51 wherein the piston subassembly includes six pistons, single pistons centrally positioned on opposite ends of the slide body having a outer diameter larger than the outer diameter of pistons above and below the centrally positioned pistons.

54. An internal combustion engine including a plurality of linearly reciprocal pistons, all of the pistons moving in the same direction during each stroke, and a flywheel having an axis of rotation substantially perpendicular to the direction in which the pistons move,

the flywheel having sufficient angular momentum to dampen reaction forces acting in a direction opposite from the direction of movement of the pistons during sequential strokes due to the expansion of a combustible fuel-air mixture sequentially acting on individual pistons so that the internal combustion engine can be employed in a mobile vehicle.

55. The internal combustion engine of claim 54 in which the flywheel is connected to the pistons.

56. The internal combustion engine of claim 55 in which the flywheel also comprises means for reducing fluctuations in piston velocity during each stroke.

57. The internal combustion engine of claim 54 in which multiple pistons are rigidly connected to each other.

58. The internal combustion engine of claim 57 wherein the multiple pistons comprise portions of a one-piece member.

59. The internal combustion engine of claim 58 in which the one-piece member comprises a cast member.

60. The internal combustion engine of claim 58 wherein the flywheel is located in a plane parallel to and adjacent to a central portion of the one-piece member, the pistons extending in opposite directions from the one-piece member.

61. The internal combustion engine of claim 60 wherein the pistons are located beyond the periphery of the flywheel.

62. The internal combustion engine of claim 61 wherein portions of the pistons overlay the flywheel beyond the periphery of the flywheel to reduce a moment arm between resultant forces action on the pistons due to combustion and the center of mass of the flywheel.

63. The internal combustion engine of claim 54 wherein the pistons comprise portions of a piston subassembly and the flywheel has a mass greater than the piston subassembly.

ABSTRACT

An internal combustion engine includes a slide body having a plurality of rigidly mounted pistons on opposite ends of the slide body. The slide body reciprocates and is connected to a flywheel by a pin and track configuration. Both the slide body and the flywheel are mounted on the interior of the engine. Magnets on the flywheel rotate relative to stationary coil conductors to induce a current. The housing includes four panels, which can be easily assembled and disassembled for form a housing compartment in which the linearly movable slide piston subassembly and the rotating flywheel are positioned.

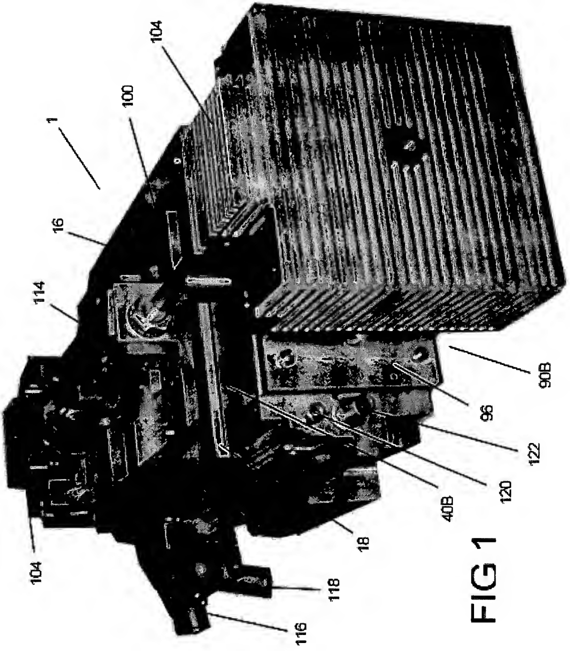


FIG 1

FIG 2

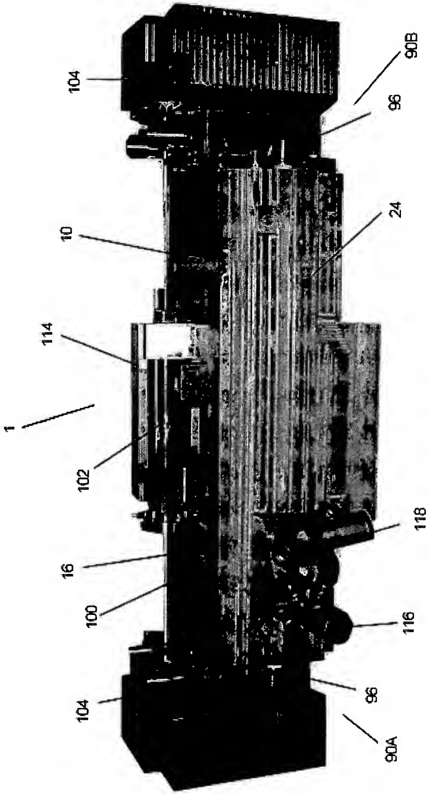
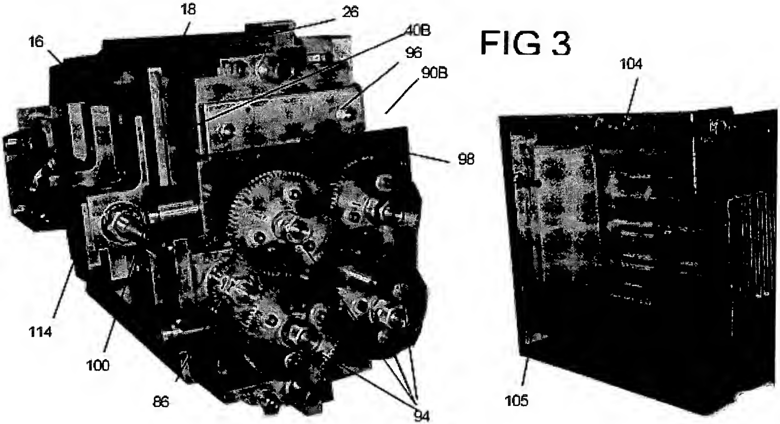


FIG 3



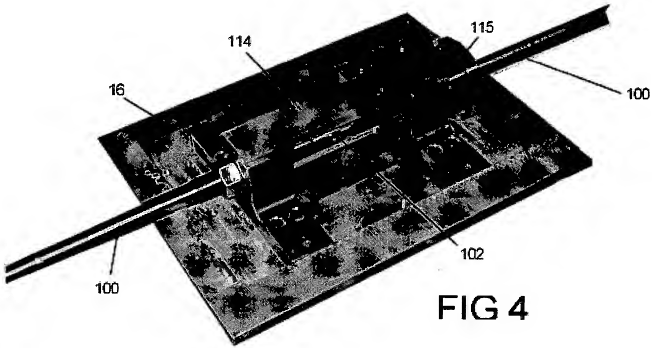


FIG 4

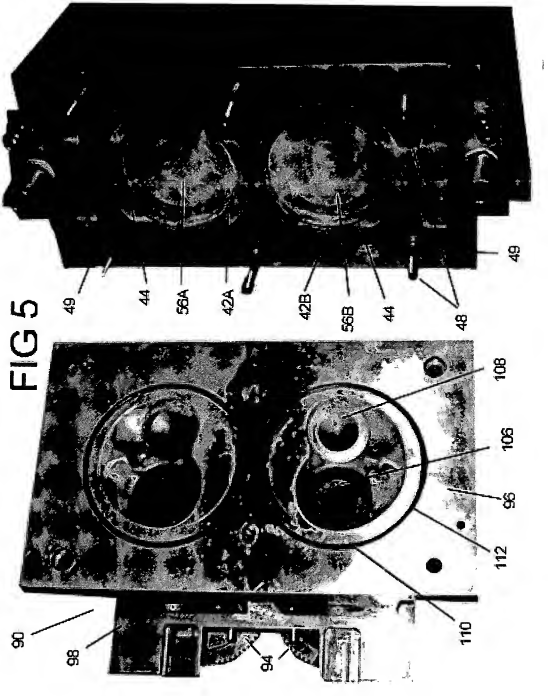


FIG 5

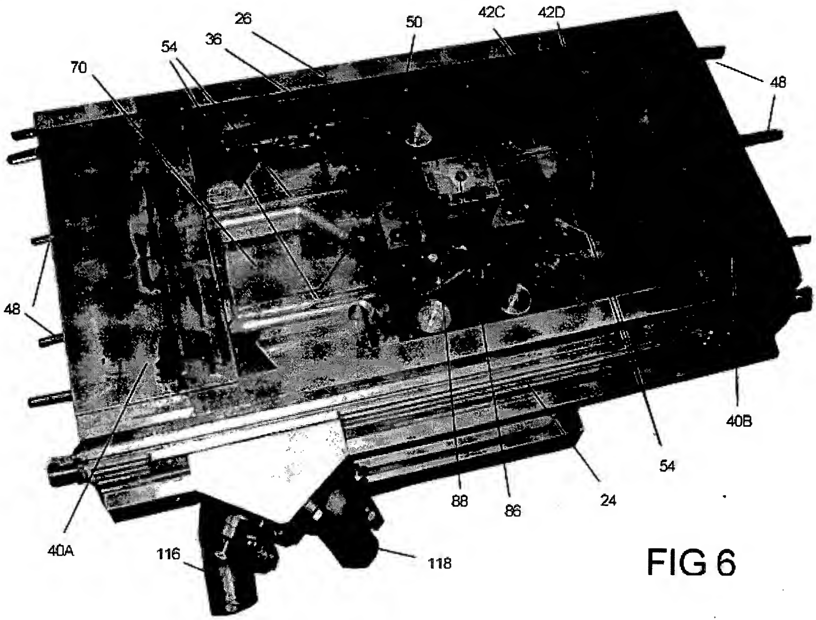


FIG 6

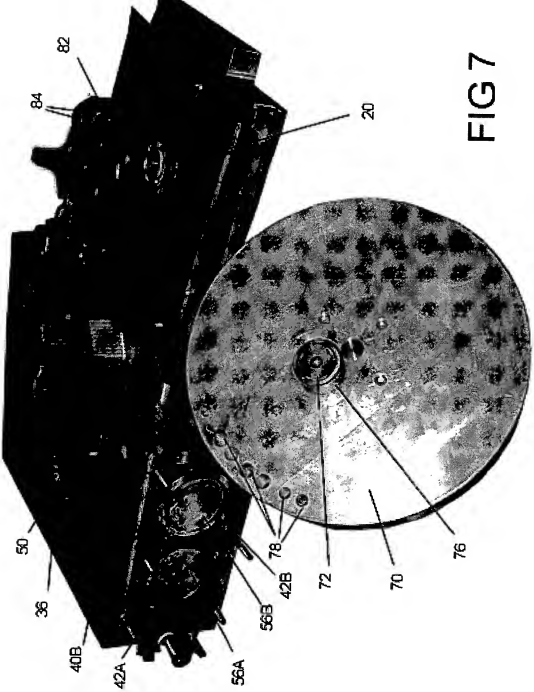
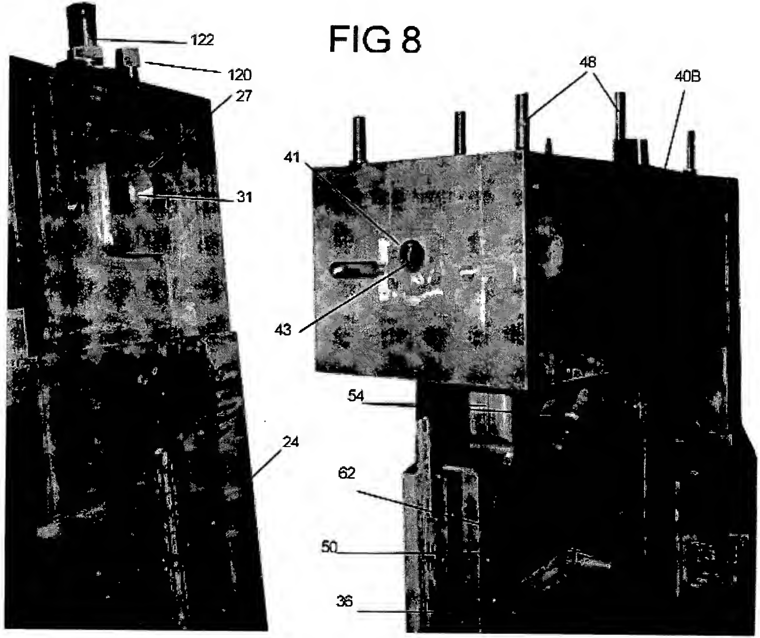


FIG 7

FIG 8



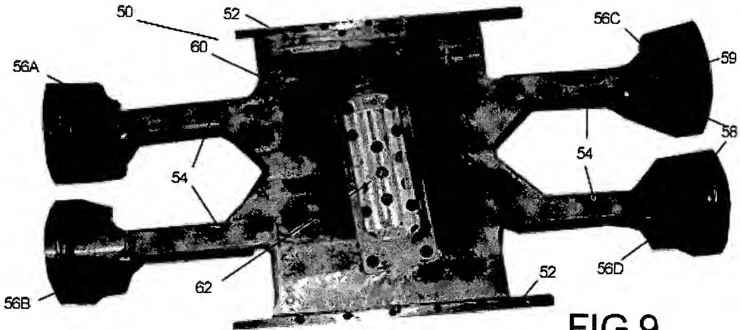


FIG 9

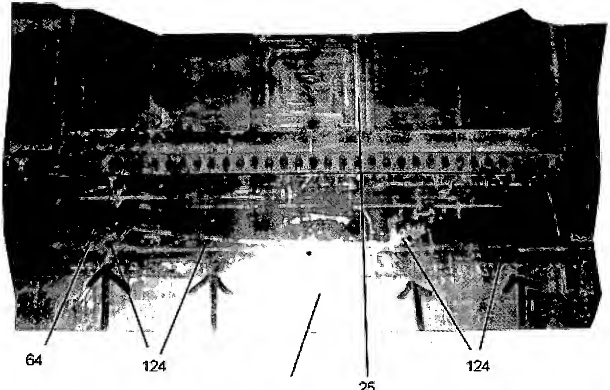


FIG 10

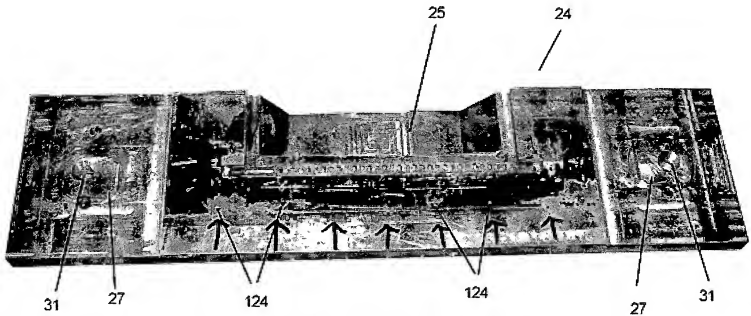


FIG 11

FIG 12

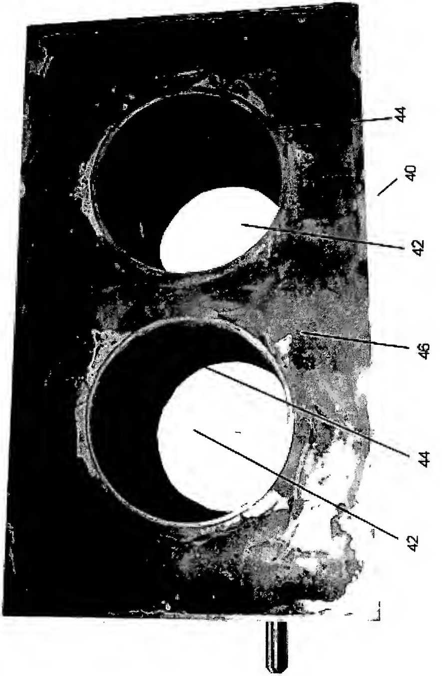
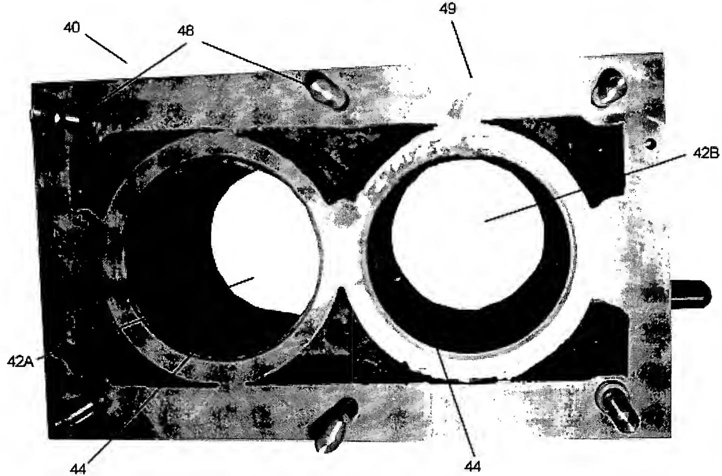


FIG 13

FIG 14



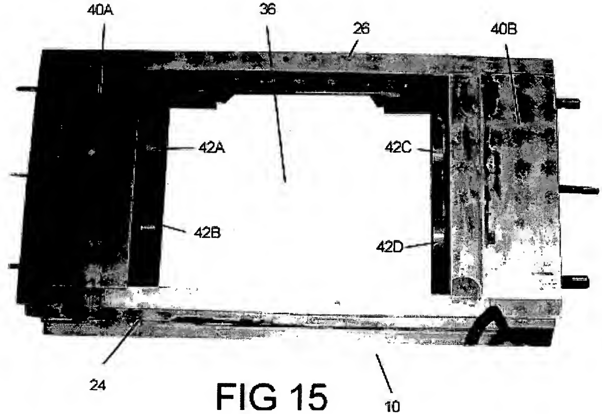


FIG 15

FIG 16

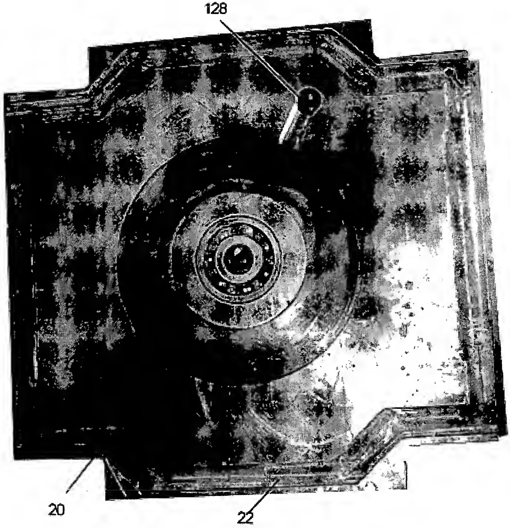


FIG 17

FIG 18

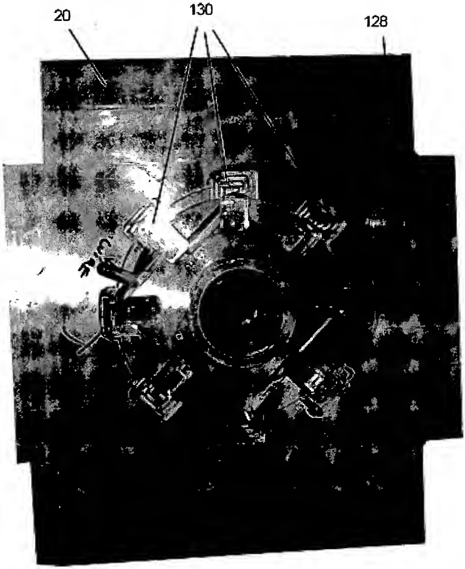
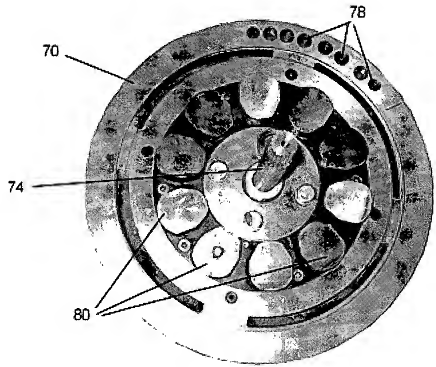


FIG 19



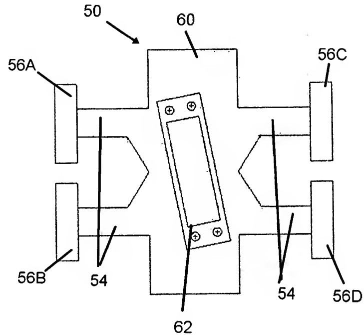


FIG 20

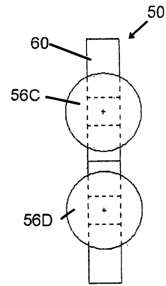


FIG 21

FIG 22

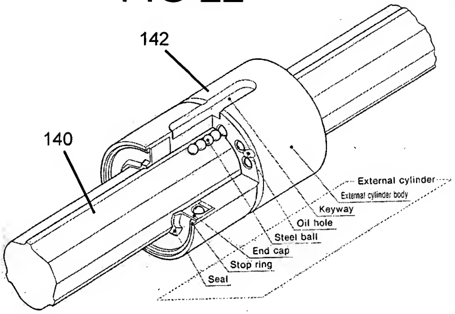

142
140
External cylinder
External cylinder body
Keyway
Oil hole
Steel ball
End cap
Stop ring
Seal

FIG 23

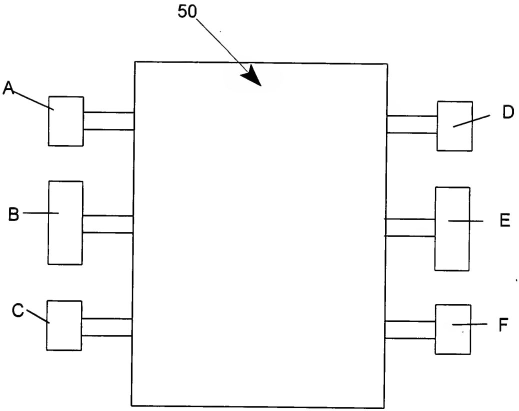


FIG 24

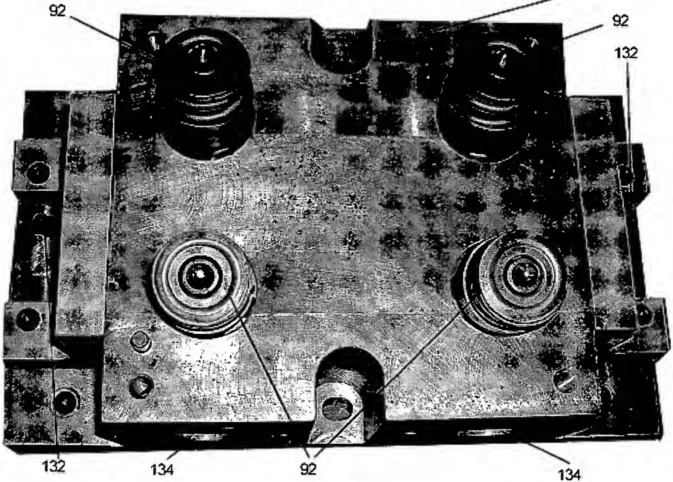
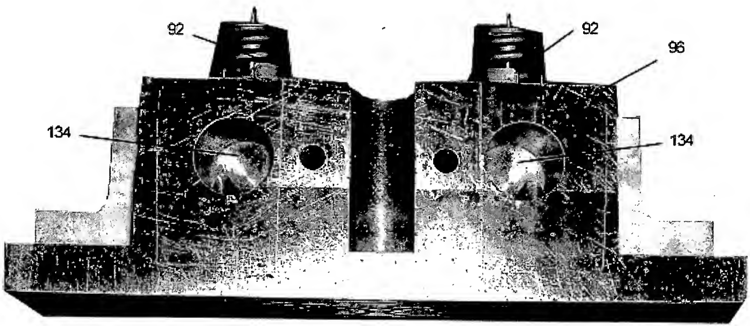


FIG 25



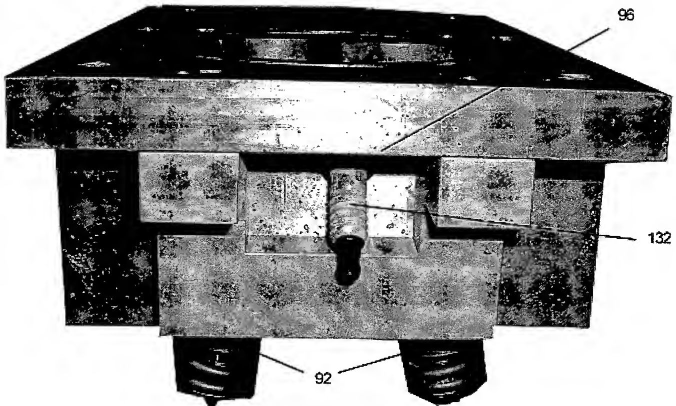


FIG 26

FIG 27

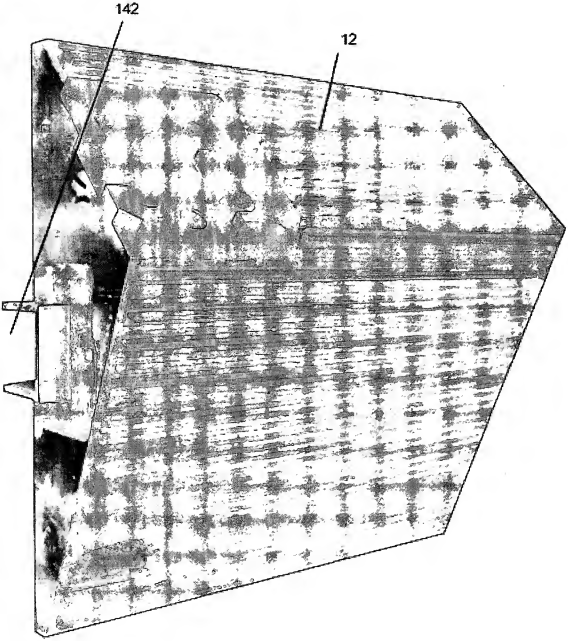


FIG 28

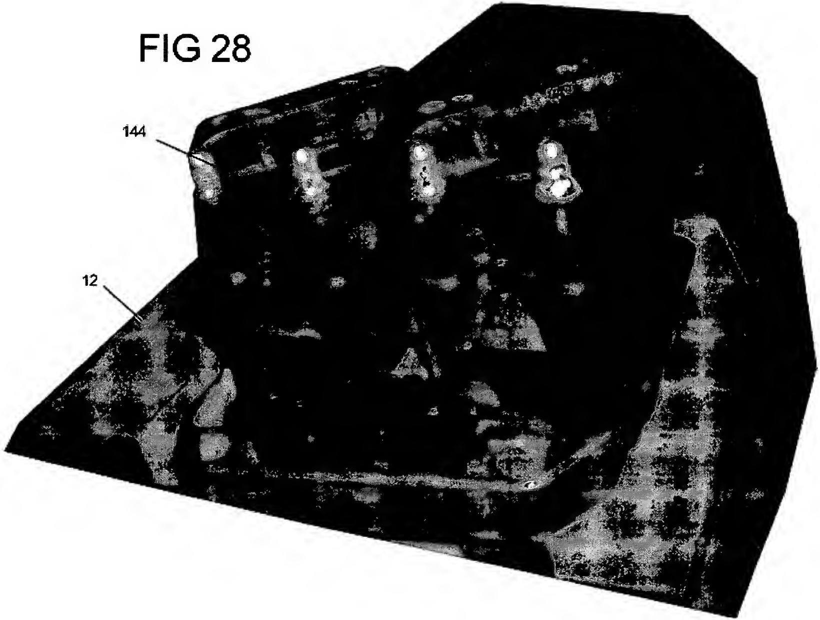


FIG 29

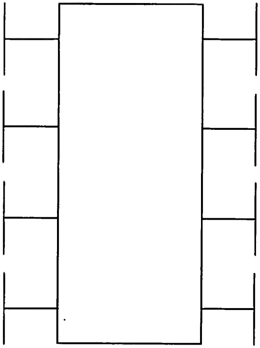


FIG 30